1.0 INTRODUCTION

0400

The Tetra Tech, Inc. (Tetra Tech) Superfund Technical Assessment and Response Team (START) was tasked by the U.S. Environmental Protection Agency (EPA) Region 7 Superfund Division to conduct a Removal Assessment and assist with a Removal Action at the Beta-Chem site in Lenexa, Kansas. During its operation, the Beta-Chem facility produced custom-manufactured, radio-pharmaceutical-synthesized compounds using carbon-14 as a dating mechanism. As part of the assessment activities, EPA and Tetra Tech assessed the Beta-Chem site for radioactive impacts resulting from previous site use. The radiological assessment included (1) assessing internal and external carbon-14 concentrations of chemical containers, (2) assessing interior surfaces and site equipment, (3) assessing site soils, (4) conducting indoor air monitoring, and (5) conducting an assessment of the 14412 West 100th Street building.

Danny O'Connor was the START project manager for the assessment activities. The EPA On-Scene Coordinator (OSC) for the project was Doug Ferguson.

2.0 REMOVAL ASSESSMENT ACTIVITIES

The following sections describe radiological assessment activities.

1.1 CHEMICAL CONTAINER ASSESSMENT

During the removal assessment at the Beta-Chem site, EPA and START assessed chemical containers for internal and external carbon-14 contamination. A Ludlum Model 2241 ratemeter with a Model 44-9 Geiger-Mueller (GM) pancake detector (Ludlum 44-9 detector) and a Ludlum Model 3030 alpha/beta sample counter (Ludlum 3030) were used for this portion of the assessment. During initial assessment activities at the Beta-Chem site, 1,134 chemical containers were identified, including 17 carbon-14 source containers. After completing the container inventory, chemicals were segregated according to hazard class. Similar and compatible chemicals were then bulked by waste stream (211 total chemicals bulked). Bulked waste streams included: flammable liquids, halogenated liquids, liquid organic acids, liquid inorganic acids, solid bases, and liquid bases. To assess for possible carbon-14 contamination within bulked chemicals, START collected samples from each bulked waste stream and submitted the samples for laboratory analysis of carbon-14 via liquid scintillation counter. A majority of chemicals were not bulked due to incompatibilities or reactiveness. Samples were collected from these chemicals to quantify carbon-14 concentrations. In addition, wipe samples were collected (from the label and lid) to assess for possible removable carbon-14. Three laboratories were used for the analysis of carbon-14: TestAmerica Laboratories, Inc. (TestAmerica), GEL Laboratories, LLC (GEL), and the University of Kansas

Environment, Health and Safety Program Radiation Safety Office (KU Radiation Lab). Four wipe samples were submitted to TestAmerica. Ten chemical samples were submitted to GEL in Charleston, South Carolina. Six hundred seventy-three chemical, three hundred fifty-three wipe, and eight wipe samples were submitted to the KU Radiation Lab. Summary statistics from internal and external container samples are in Table 1.

TABLE 1

SUMMARY STATISTICS FROM INTERNAL AND EXTERNAL CONTAINER ASSESSMENT

	Chemical Samples		Wipe Samples (dpm/ 100cm^2)
	Liquid (dpm/ml)	Solid (dpm/g)	
Low	ND	ND	35
High	1,500,336	1,373	369,903

Notes:

Awaiting complete laboratory data package from the KU Radiation Lab to complete table.

dpm/100cm^2	disintegrations per minute per 100 square centimeters
dpm/ml	disintegrations per minute per milliliter
dpm/g	disintegrations per minute per gram
ND	Below detection limits

1.2 ASSESSMENT OF INTERIOR SURFACES AND EQUIPMENT

Assessment of Interior Surfaces

Interior surfaces of the Beta-Chem site were assessed using a Ludlum Model 2241 ratemeter with a Ludlum 44-9 detector. A 10 microCurie (μCi) carbon-14 check source was used to calculate an efficiency of 2.5 percent for the 44-9 detector. Site screening standards were established as 6,000 dpm/100 cm^2 for removable contamination and 60,000 dpm/100 cm^2 for total contamination. Interior surface assessment included quantifying removable and total contamination.

To determine the amount of removable vs fixed contamination, EPA and START personnel surveyed three surfaces prior to and after application of solvents used in an attempt to decontaminate the surfaces. First, crews collected static readings from the surfaces using a Ludlum 44-9 detector. Next crews quantified removable contamination by collecting wipe samples. The samples were counted using a Ludlum 3030 with a subset of samples being submitted for laboratory confirmation analysis. The amount of removable contamination compared to fixed contamination was minimal, suggesting a majority of contamination is fixed. In an effort to assess the potential effect of decontamination, multiples solvent types (wet wipes,

vinegar, and alcohol) were applied and the surfaces were reassessed. The decontamination process produced minimal to no effect on static radiation readings, although, removable contamination readings were noticeably lowered. Static radiation readings exceeded the screening standard for total contamination of 60,000 dpm/100cm^2 in all instances. A summary of results from the decontamination process are included in Table 2.

TABLE 2

SUMMARY OF INTERIOR SURFACE SURVEY

Assessed Location	Solvent Applied to Surface (Yes/No)	Static Reading (cpm)	Static Reading Conversion (dpm/100cm^2)	Swipe Reading (α/β cpm)	Laboratory Swipe Reading (cpm/100cm^2)
Fume hood sash	No	1.2 k	391,488	0/135	-
	Yes (wet wipe)	1.2 k	391,488	0/42	-
	Yes (vinegar)	1.2 k	391,488	-	-
	Yes (alcohol)	1.2 k	391,488	-	-
Exposed wooden beam	No	1.5 k	489,360	0/198	-
	Yes (wet wipe)	0.9 k*	293,616	0/96	-
	Yes (vinegar)	1.2 k	391,488	-	-
	Yes (alcohol)	1.2 k	391,488	-	-
Floor below fume hood	No	2.6 k	848,224	0/403	-
	Yes (wet wipe)	2.6 k	848,224	0/33	-
	Yes (vinegar)	2.5 k	815,600	-	-
	Yes (alcohol)	2.5 k	815,600	-	-
	Yes (baking soda)	2.3 k	750,352	-	-

Notes:

α	alpha radiation
β	beta radiation
cpm	counts per minute
dpm	disintegrations per minute
k	thousand
cm^2	square centimeters

Crews then assessed a majority of surfaces throughout Beta-Chem. During this portion of the survey, a Ludlum 44-9 detector was used to collect static measurements (total contamination). Using the below equation, EPA and START calculated a Ludlum 44-9 detector reading (180 counts per minutes [cpm]) that equates to the site established screening level of 60,000 dpm/100cm^2.

$$60{,}000 \text{ dpm}/100\text{cm}^2 \times 2.5\% \times \frac{12.26 \text{ cm}^2}{100 \text{ cm}^2} = 180 \text{ cpm}$$

The following were identified with static radiation readings (total contamination) exceeding 180 cpm in the northwest portion of the lab: all four fume hoods, the refrigerator, all exposed wood surfaces, flooring, most wall board, ceiling tile, air supply and return vents, wall phones, handles on gas cylinders, the sink, countertops, faucet handles, glassware, equipment under the sink, and glassware drying panel knobs.

The following were identified with static radiation readings exceeding 180 cpm in the northeast portion of the laboratory: a fume hood, a semi-portable fume hood, a table supporting the fume hood, interior walls, wall board, exposed wood, some compressed gas cylinder handles, buttons on equipment, exposed wood, flooring, ceiling tile, return and supply air ducts, shelves in flammable cabinets, lab clamps, glassware, cabinet handles, items within rolling drawers, cardboard box exteriors, the door leading into the laboratory, and trash under a desk.

The following were identified with static radiation readings exceeding 180 cpm in the south portion of the laboratory: chairs, ceiling tile, the furnace, flooring, and trash.

Assessment of Equipment

EPA and START personnel attempted to quantify possible contamination of equipment stored at the Beta-Chem site. Table 3 summarizes assessment of equipment.

TABLE 3

SUMMARY OF EQUIPMENT SURVEY

Equipment Item	Location Assessed	Decontaminated (Yes/No)	Static Reading (cpm)	Swipe Reading (cpm)	
				α	β
Liquid Scintillation Spectrometer	Handle	No	1.1 k	0	108
		Yes (wet wipes)	1.1 k	0	79
	On/Off buttons	No	850	0	612
		Yes (wet wipes)	600	0	204
	Top lower right exterior corner	No	1.1 k	0	184
		Yes (wet wipes)	1.0 k	0	112
BID System 100 Bioscan, Inc.	Instrument Panel High Voltage Switch	No	2.3 k	0	43
		Yes (wet wipes)	1.9 k	-	-
	Top of instrument	No	700	-	-
	Sides	No	550	-	-
	Black valve in back	No	1.6 k	0	477
		Yes (wet wipes)	1.4 k	0	45
	IBM Computer	No	650	0	1,312
		Yes (wet wipes)	400	0	61
	Instrument Panel face	No	-	0	81
		Yes (wet wipes)	-	0	108
Varian 9050 Variable Wavelength UV-VIS Detector	Panel	No	700	0	363
		Yes (wet wipes)	700	0	139
	Top of instrument	No	550	0	60
		Yes (wet wipes)	500	0	40
	Lower panel	No	500	0	147
		Yes (wet wipes)	450	0	52
Canberra Radiomatic Flo-One Beta (Radio Chromatography Detector, Series A-100)	Side panels	No	850	0	64
		Yes (wet wipes)	1.0 k	0	45
	Top of lab alliance	No	600	0	162
		Yes (wet wipes)	700	0	36
	Radiomatic panel	No	1.0 k	0	93
		Yes (wet wipes)	900	0	58
	Black panel in back	No	300	0	126
		Yes (wet wipes)	350	1	51
Varian 3400 Gas Chromatograph	Panel	No	1.0 k	0	82
		Yes (wet wipes)	1.1 k	0	51
	Top	No	550	0	123
		Yes (wet wipes)	500	0	54
Buchler Digital Rotary Evaporator	Bottom glassware attachment	No	5 k	0	4,107
		Yes (wet wipes)	5 k	0	354
	lower right knob	No	10 k	0	747
		Yes (wet wipes)	10 k	1	78
	upper knob	No	8 k	0	370
		Yes (wet wipes)	6 k	0	78
Blue Radiation Meter (GSM-110, serial number 6134)	display	No	1.1 k	0	111
		Yes (wet wipes)	1.1 k	0	45
Ludlum Model 3 with 44-9 detector (serial number 229349)	dial	No	300	0	157
		Yes (wet wipes)	300	0	48
WM B. Johnson Meter Model DIG-5 (serial number 329)	switch	No	200	0	55
		Yes (wet wipes)	200	0	42

Notes:

α alpha radiation
β beta radiation
cpm counts per minute
k thousand

In addition to the survey of equipment summarized in Table 3, a 20 μCi radium-226 check source was observed within the Packard Liquid Scintillation Counter in the northeast portion of the laboratory.

1.3 SOIL SAMPLING AND RESULTS

Soil sampling was conducted at the Beta-Chem site on May 9, 2014. Eighteen soil samples were collected from exposed soil northwest of the facility. To ensure adequate site coverage, a triangular gridding system was used to establish ten sample locations (G1-G10). A single aliquot was collected from each location and recorded in the site log book. In addition, a Ludlum 2241 ratemeter and Ludlum 44-9 detector were used to scan surface soils to identify areas of elevated activity. Eight distinct areas were identified with readings distinguishable from background. A single aliquot sample was collected from each location (HS1-HS8). Samples were submitted to TestAmerica for analysis of Carbon-14 via Liquid Scintillation Counter. Table 4 summarizes analytical data from samples collected from Beta-Chem.

TABLE 4

SUMMARY OF SOIL SAMPLE ANALYTICAL DATA

Sample Name	Carbon-14 Laboratory Result (pCi/g)
G1	45.7
G2	9.08
G3	3.80
G4	27.8
G5	15.9
G6	223
G7	30.1
G8	21.6
G9	71.2
G10	7.03
HS1	119
HS2	438
HS3	960
HS4	23.8
HS5	361
HS6	120
HS7	55.6
HS8	42.8

Notes:

G	Grid sample
HS	Hot spot
pCi/g	picoCurie per gram

In addition, five soil samples were collected from a reference area (Electric Park) to quantify background carbon-14 concentrations in the site vicinity. Table 5 summarizes background sample analytical data.

TABLE 5

SUMMARY OF BACKGROUND SAMPLE ANALYTCAL DATA

Sample Name	Carbon-14 Laboratory Result (pCi/g)
BG-1	0.510
BG-2	0.254
BG-3	0.0362
BG-4	0.247
BG-5	0.432

Notes

BG Background
pCi/g picoCuries per gram

The Memorandum of Understanding between the EPA and the Nuclear Regulatory Commission (NRC) lists two consultation triggers for carbon-14: 46 pCi/g for residential soil and 123,000 pCi/g for industrial soil. The Beta-Chem site is located in a commercially zoned area without nearby residences; therefore, the industrial soil standard was chosen for comparison. No reported carbon-14 concentrations from soil samples collected at Beta-Chem exceeded the industrial soil standard.

1.4 AIR MONITORING

During assessment and removal activities at the Beta-Chem site, air monitoring was conducted to measure airborne concentrations of radioactive material. Air monitoring was conducted using RADeCO® Model H-810 high-volume air samplers and a Ludlum 3030. Air samplers were positioned in high traffic areas of the building and ran continuously during activities. Paper filter samples were collected each day from the samplers and analyzed for radiological contamination by EPA and START using the Ludlum 3030. Based on the measurements obtained from the filter samples, airborne beta radiation did not exceed the derived air concentration (DAC) of radionuclides for occupational exposure (15 cpm per cubic foot [ft^3]).

1.5 ADJACENT BUILDING ASSESSMENT

On July 16, 2014, EPA and START assessed the 14412 West 100th office (Mar Tech, Inc.) for possible radioactive contamination. The Mar Tech, Inc. office shares its' west wall with the Beta-Chem facility.

The tenant expressed concern with possible contamination spreading from Beta-Chem due to a water line break during the winter of 2013/2014. To assess gross radioactivity in the office, crews used a Ludlum 2241 ratemeter and Ludlum 44-9 detector to collect measurements in the office. The highest observed reading was 50 cpm above background from the northeast wall of the storage room. Swipe samples were collected from seven locations within the office, including the northeast wall. The samples were screened using a Ludlum 3030 with readings recorded in the site log book. The samples were then submitted to the KU Radiation Lab for analysis of carbon-14 via liquid scintillation counter. Table 6 presents results from field screening and laboratory analysis of swipe samples collected from the Mar Tech, Inc. office.

TABLE 6

SUMMARY OF SWIPE SAMPLING AT 14412 WEST 100TH STREET

Sample Name	Ludlum 3030 Reading		Carbon-14 Laboratory Results (pCi/100cm²)
	α (cpm)	β (cpm)	
M-1	0	27	-
M-2	0	42	-
M-3	0	43	-
M-4	0	48	-
M-5	0	57	-
M-6	1	52	-
M-7	0	52	-

Notes:

α	Alpha radiation
β	Beta radiation
cpm	counts per minute
$pCi/100cm^2$	picoCuries per 100 square centimeters